VIRUSES AND MAN[1]

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The activities of the Sanitarian are as broad as the field of public health. Since he is expected to know the answers to a wide variety of problems, he must try to keep up with the rapidly increasing amount of information arising from scientific research. One of the basic areas within the scope of his activities is the control of communicable diseases. To be effective in this area he must have information concerning the cause of disease, where it has occurred, when it occurred, the humans or animals involved, how it was transmitted, and other epidemiological data. The youngest member of the microbiological family, and one with which sanitarians should have a working knowledge is the group comprising the viruses.

SIZES OF VIRUSES

At the outset, it is very difficult to describe the viruses because events have happened so quickly that when we say they are the "smallest living things" we must qualify each word with a definition. Facts are needed before conclusions are drawn or statements made. For example, the story is told about an Oxford medical student who dug up an ancient university regulation which said he was entitled to a pint of beer while he crammed for his final exams. He was so persistent that the authorities provided him with his pint, but they also searched through the regulations and fined him five pounds for not wearing a sword! This was a case where a little bit of knowledge was dangerous, and the sort of situation to be studiously avoided.

The "smallest" means that it is measured in millimicrons. A millimicron is one one-thousandth of a millimeter, and Influenza A (PR8) for example, is about 100 millimicrons, while polio virus has an average diameter of 10 millimicrons. They appear to be "living" in that they reproduce. Recent scientific advances, however, require some reflection on the meaning of this term, since viruses have been crystallized and fractionated by biochemical procedures. Thus, ribonucleic acid obtained from polio virus, *(1)* was changed by phenol into an infective unit. The enzyme ribonuclease is capable of destroying it, and various inorganic substances assist the process of infection by depletion of calcium in the infected cells. Thus, a chemical has caused infection; this may indicate an expansion or perhaps a restatement of the germ theory of disease.

To reflect for a moment longer on the concept of size, have you ever calculated the number of staphylococci which theoretically would fit in one cubic centimeter? Assume that the organism is one micron in diameter. Since it is spherical, its volume then becomes approximately 0.5 cubic microns. A cubic centimeter is equivalent to 10^{12} or one million million cubic microns, and it would therefore accommodate 2×10^{12}, or two million million staphylococci. On this basis one cubic centimeter could house 2×10^{20} polio viruses. These astronomical numbers tax the imagination and they do give some meaning to the tremendous infectious potential of small amounts of material.

NATURE OF VIRUSES

The viruses not only are parasites, but they are strictly so, since they multiply only within living cells. The bacterial viruses, known as bacteriophages *(2)* cause the bacteria to disintegrate or undergo lysis. During this process the phages reproduce in large numbers. Extensive research with the bacteriophages has shown that they enter the genetic apparatus of the cell and may change it. Ribonucleic acid (RNA) stores a great variety of biological information. The molecule of nucleic acid consists of about 1,000 building blocks known as nucleotides. Each of these contains phosphoric acid, sugar, and one of four bases: adenine, guanine, cytosine and uracil, in the case of RNA; or adenine guanine, cytosine and thymine in the case of deoxyribonucleic acid (DNA). It has been estimated by W. M. Stanley, the Nobel laureate who crystallized tobacco mosaic virus, that a 1000-unit nucleotide chain containing a coded repeat of these four bases could form about 10^{590} different arrangements. A 100-unit chain could exist in 10^{57} arrangements. He points out that these galactic numbers could carry the code for every bit of life on earth and in the sea.

Another property of viruses is that they may remain dormant or latent in the host cell. If these same characteristics should apply to humans, then changes in metabolism might give a hidden virus the chance to manifest itself. This could result when the bio-

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logical balance between host and parasite is upset and sickness could occur without any apparent immediate cause. The epidemiological implications are quite significant.

VACCINES, PHYSICAL AND CHEMICAL AGENTS

Among other properties of viruses of interest to the sanitarian are those relating to vaccines, the effects of physical and chemical agents, and how viruses are classified. The virus, being protein in nature, can be used as an antigen and will elicit the formation of antibodies. This means that one can build an immunity to virus diseases such as smallpox, yellow fever, and poliomyelitis. Most viruses can be inactivated by ultra violet light or by heating to 140°F for 30 minutes. They can withstand freezing and may be stored at the temperature of dry ice (-76°F). Some are quite resistant to dessication and will remain viable in dust or mucous. Generally speaking, the antibiotics are not virucidal, but there are some exceptions. Viruses may be inactivated by chemicals and in general, are a little more resistant than vegetative bacteria to halogens, phenols and peroxides. However, they are less resistant than spores.

RELATION TO WATER SUPPLIES

With respect to water supplies, viruses have been studied extensively *(3)*. Slightly turbid water which was artifically contaminated with poliomyelitis virus wan rendered noninfectious after 24 hours by 4 ppm of chlorine, while 0.4 ppm sufficed in clear water. In tap water, 1.5 ppm chlorine inactivated the virus in 20 minutes, but a concentration of 0.55 ppm required 1 hour. These experiments tell little about what the usual water purification methods would do if virus were present in small concentration. To date there is no evidence that poliomyelitis is transmitted by drinking water.

CLASSIFICATION

There are many methods of classification varying from the name of the place, (Colorado tick fever) to the name of an animal, (Equine encephalitis), or a particular tissue, (acute anterior poliomyelitis). Some are known as ECHO, meaning enteric cytopathogenic human orphan viruses, while ECMO would pertain to monkeys, ECBO to cattle, and ECSO to swine. These abbreviated designations are a part of the jargon of virologists and may present some difficulties to the uninitiated.

CONCLUSION

What does all of this mean to sanitarians? Briefly, we should continue to emphasize the measures now in use for the control of communicable diseases, since they apply to viruses as well as bacteria. The usual rules for maintenance of good health should keep the biological balance in favor of man. Environmental sanitation is still a foundation stone in public health practice, whether as Dr. Rosenau used to say, "one speaks of the hygiene of the alimentary canal or the sanitation of the Panama canal."

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3. Krumbiegel, E. R. Transmission of Virus Diseases by Water. J. Am. Water Works Assn. **36**: 81-85. 1944.

4. Additional Information may be obtained from: *Textbook of Virology*. Rhodes, A. J. and van Rooyen, C. E. Williams and Wilkins Co. 1958.